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STAR CLOUDS IN OUR GALAXY.

By RICHARD A. PROCTOR.

IT is singular how persistently even simple errors, if supported by great names, are repeated by the many who care only to think as others tell them to think. One of the most striking illustrations of this is to be found in the theory of nebulæ or star-clouds, quoted again and again in our books of astronomy, as if it were based on observation and direct evidence, instead of being originally but a guess, and a guess which will not bear investigation.

In the later portion of his observing career, the great astronomer, Sir W. Herschel, who had earlier regarded all nebulæ as aggregations of stars, adopted and enforced the theory that many among them are great masses of self-luminous gas. Yet he still retained the idea that large numbers of these objects are great aggregations of suns akin to our own galaxy. According to this view, the nebulæ of the star-clustering kind are galaxies external to our system of stars; they are "island universes" as Humboldt poetically said. Sir John Herschel even indicated among them one which he regarded as not only a galaxy resembling our own in general characteristics, but as one in which the chief details of its structure can be recognised. Arago and other astronomers deservedly eminent have adopted this theory of external star galaxies. Popular writers have accepted the doctrine, and dwelt, not without reason, on the magnificence of the conception that, marvellous as are the glories, mysterious the profundities of our stellar system, they are repeated, with variations perhaps in detail, but resemblance in general character—among thousands of star systems within telescopic range, and doubtless among millions beyond the reach of the most powerful telescopes man has ever made.

Yet as I showed sixteen years ago (though Mr. Herbert Spencer, clearest of thinkers, had been beforehand with me by many years) there are reasons so strong for rejecting this theory that they need only to be mentioned to be found convincing.

Thus, towards the end of his observing career, Sir W. Herschel found that even with his most powerful telescopes he could not resolve all parts of the Milky Way. Parts of our own system of stars are too remote, then, it seems, to be resolved into stars. Of course, in these parts, the stars may be much smaller and more closely set than elsewhere, but to admit this—which is probable, nay, I believe, unquestionably true—is to adopt a view more essentially inconsistent with Herschel's original ideas respecting the galaxy, than is the one we are dealing with. If, then, the most powerful telescopes yet made by man cannot resolve the remoter parts of the galaxy to which our sun belongs, which cannot lie so much as a diameter of the galaxy from us, how can any such telescope possibly resolve galaxies so remote as to be reduced to mere specks, lying, in fact—as their apparent diameters show—at a distance exceeding many hundred times their real diameters? Mr. Herbert Spencer has admirably shown the inherent absurdity of the notion to which many (especially many professional astronomers, who appear to imagine that measuring star-places must give them an insight into astronomical truths) cling as if it were a demonstrated truth. "Take a homely example," he says: "Suppose a man, surrounded by a swarm of bees extending, as they sometimes do, so high in the air as to be individually almost invisible, were to declare that a certain spot on the horizon was a swarm of bees, and that he knew it because he could see the bees as separate specks. Astounding as the assertion would be, it would not exceed in incredibility this which we are criticising."

Consider again the way in which nebulæ are arranged on the star-sphere. Whether we consider the broader features of arrangement or specific details, we find the clearest evidence that the nebulæ belong to our galaxy, and not to outside space. The regions richly strewn with stars are almost entirely free from nebulæ, excepting two very special regions, presently to be considered. Is it likely to be an accident which has thus left those parts of the star-sphere where nebulæ most do congregate less richly supplied with stars than the rest? Then consider details. Not only is the peculiarity true of the star-sphere regarded in its broader features, but it is true of its smaller portions. The spaces near nebulæ and groups of nebulæ contain but few stars. Arago dwells on this, not noting its significance. "Herschel," he says, "found the rule to be invariable. Thus, every time that, during a short interval, no star approached, in virtue of the diurnal motion, to place itself in the field of view of his motionless telescope, he was accustomed to say to the secretary who assisted him" (his sister, to wit—Miss Caroline Herschel), "'Prepare to write; nebulæ are about to arrive!'"

Mr. Spencer has admirably pointed out the significance of this "invariable rule." "Shall we believe that, in thousands of cases, the far-removed galaxies happen to agree in their visible positions with the thin places of our own galaxy? Such a belief is next to impossible." Combined with what we have learned about the general arrangement of nebulæ, the evidence is absolutely decisive. The nebulæ must of necessity form part and parcel of the system with whose features, broad as well as more detailed, they thus closely correspond.

But there is even simpler evidence (we cannot say more striking or more conclusive evidence, for none could be *that*), proving that nebulæ are what they look like, clustering aggregations of small stars, and not (what they might have been found to be) remote congeries of suns like our own galaxy of such orbs. In the Magellanic clouds, whose figure shows them to be really round—that is, nearly globular systems in space—nebulæ of all kinds are found in great numbers in company with many stars, the spaces around the nubeculæ being free alike from nebulæ and discrete stars. Now, from the observed apparent size of the

nubeculæ, the farthest part of either of these globe-shaped aggregations cannot be farther from us than the nearest part in greater degree than as ten to nine. Within these narrow limits of distance are many orders of stars (from the seventh magnitude to the lowest discernible with very powerful telescopes) and all orders of nebulæ. It is certain, therefore (and, "which is else," it is obvious), that these nebulæ are not, as the common theory asserts of all nebulæ, many hundreds of times more remote than the discrete stars. To use Sir John Herschel's own words, "It must be taken as a demonstrated fact that stars of the seventh or eighth magnitudes and irresolvable nebulæ may co-exist within limits of distance not differing in proportion more than as nine to ten."

The nebulæ, then, are certainly, for the most part, and most probably without exception, portions of the grand galaxy of which our sun is a member. They are among the features which indicate its variety and complexity of structure. They are also features which must be taken into account in any theory which is intended to give an account of its origin and development.

THE BIRTH AND GROWTH OF MYTH.

IX.

By Edward Clodd.

I HOPE that no reader of these papers will gather from the closing words in my last chapter that there is a desire to covertly intrude religious questions into them. My agreement with the clear definition of the aim and limitation of the contributions to KNOWLEDGE, which the editor gave in its earlier numbers, when certain correspondents show eagerness to impart the *odium theologicum*, would in itself be sufficing check. And if that would not, the editor's eagle eye would soon detect the cloven foot.

At the same time, the scientific character of KNOWLEDGE requires that whatever is matter of historical explanation should have place in its columns. For the term science includes much more than was conceded before the "Origin of Species" was published. Not twenty years ago, Mr. Froude was at some pains in endeavouring to refute Mr. Buckle's theory that a science of man is possible because the origin of his ideas and the sources of his actions, both individually and socially, are traceable to physical causes. Incomplete as was Mr. Buckle's theory, and obscured as it now is under the greater light of the doctrine of descent with modification, he was on the right track. For if man is a part of nature, then there is a science of him not only attainable, but demanded; a science of him intellectually, emotionally, spiritually, as well as physically. His relation, materially, to every kind of life on the earth; structurally, to the higher forms, is established; the natural history of him is demonstrated. But this is physical only, and for us the larger question is psychical. Here most of us are yet in the empirical stage, and here we must remain till the sequences of mental phenomena are recognised to be as determinable as those of material phenomena. But that time seems afar off, because people are frightened when the application of the same method of investigation to psychology as to physiology is urged. They say that this savours of materialism, whereas it commits us to nothing to which the idealist cannot assent. Thus much must suffice to justify what has yet to be said.

These papers would not be worth the reader's attention if they were solely concerned with bringing together illustrations of myths from semi-savage races. Their other, and indeed their primary, concern is with the origin and growth of man's effort to understand the nature and meaning of things around him, and of his own acts and feelings. In this lies primitive philosophy, theology, and science, the beginnings of all knowledge that has been and that ever will be, and in the unbroken sequence of which we find the explanation of the existence of beliefs amongst us which are discredited whenever examined. It is the persistence of these which has made it increasingly difficult, as these papers proceed, to deal with the primitive myth apart from its later and more serious forms. Myth was the product of man's emotion and imagination, acted upon by his surroundings, and it carries the traces of its origin in its more developed forms, as the ancestral history of the higher organisms is embodied in their embryos. Man wondered before he reasoned. Awe and fear are quick to express themselves in rudimentary worship; hence the myth was at the outset a theology, and the gradations from personifying to deifying are too faint to be traced. Thus blended, the one as inevitable outcome of the other, they cannot well be treated separately, as if the myth was earth-born and the theology heaven-sent. And to treat them as one is to invade no province of religion, which is quite other than speculation about gods. The awe and reverence which the fathomless mystery of the universe awakens, which steal within us unbidden as the morning light, and unbroken on the prism of analysis; the conviction, deepening as we peer, that there is a Power beyond humanity, and upon which humanity depends; the feeling that life is in harmony with the Divine order when it moves in disinterested service of our kind—these theology can neither create nor destroy, neither verify nor disprove. They can be bound within no formula that man or church has invented, but undefined—

> "Are yet the fountain life of all our day,
> Are yet a master light of all our seeing."

If thus far my readers are with me as to the unrelation between religion and formulated theology, and if these papers have shown with any clearness the emergence of the latter from primitive speculations about the gods and their doings, their sympathetic interest may be reckoned on in what has now to follow concerning the survival of some old weather-myths in beliefs that have had profound and direful influence upon human conduct and fate.

All the Aryan nations have among their legends, often exalted into epic themes, the story of a battle between a hero and a monster. In each case the hero conquers, and releases treasures, or in some way renders succour to man, through his victory. In Hindu myth this battle is fought between Indra and Vritra.

Indra, one of the Vedic gods, comes, according to Professor Max Müller, from the same root as the Sanskrit *indu*, drop, sap, but the etymology is doubtful. What is not doubtful is that he is the god of the bright sky, and, although like the other gods invoked in the hymns of the Rig-Veda, a departmental or tribal deity, a sort of *primus inter pares*, of whose many titles, Vritrahan, or "Vritra-slayer," is the pre-eminent one. The benefits showered by him upon mortals caused the attribution of moral qualities to him, and he was adored as "lord of the virtues," while the juice of the sacred soma plant was offered in his honour, for which reason he is also called Somapâ, or "soma-drinker." It is his struggle with Vritra which is a constant theme of the Vedic hymns, the burden of which remind us of the praises offered in the Psalms to Yahweh as a man of war, as mighty in battle. "The gods do not reach thee, nor men, thou overcomest all creatures in strength. . . . Thou, thunderer, hast shattered with thy bolt the broad

and massive cloud into fragments, and hast sent down the waters that were confined in it to flow at will; verily thou alone possessest all power." The primitive physical meaning of the myth is clear. Indra is the sun-god, armed with spears and arrows, for such did the solar rays appear to barbaric fancy. The rain-clouds are imprisoned in dungeons or caverns by Vritra, the "enveloper," the thief, serpent, wolf, wild boar as he is severally styled in the Rig-Veda. Indra attacks him, hurls his darts at him; they pierce the cloud-caverns, the waters are released, and drop upon the earth as rain.

Surely a most rational explanation; self-consistent as fitting into crude philosophy of personal life and volition in sun and cloud, and fraught with deep truth of meaning in regions like the Punjaub, where drought brought famine in its train.

The Aryans were a pastoral people, their wealth being in flocks and herds.* The cow yielded milk for the household; her dung fertilised the soil; her young multiplied the wealth of the family at an ever-increasing rate, and she naturally became the symbol of fruitfulness and prosperity, ultimately an object of veneration; while, for the functions which the bull performed, he was the type of strength. The Aryan's enemy was he who stole or injured the cattle; the Aryan's friend was he who saved them from the robber's clutch.

Intellectually, the Aryan tribes were in the mythopœic stage, and the personification of phenomena was rife among them. Their barbaric fancy, as kindred myths all the world over testify, would find ample play in the fleeting and varied scenery of the cloud-flecked heavens, suggestive, as this would be, of bodies celestial and bodies terrestrial. To these children of the plain the heavens were a vast, wide expanse, over which roamed supramundane beasts, the two most prominent figures in their mythical zoology being the cow and the bull. The sun, giver of blessed light, was the bull of majesty and strength; the white clouds were cows, from whose swelling udders dropped the milk of heaven—the blessed rain. But there were dark clouds also, clouds of night and clouds of storm, and within these lurked the monster robber; into them he lured the herds, and withheld both light and rain from the children of men. To the sun-god, therefore, who smote the thief-dragon, Vritra, with his shaft, and set free the imprisoned cows, went up the shout of praise, the song of gratitude. This myth, as hinted already, survives in many legends of the Aryan race, and their family likeness is unmistakable. In its Latin guise, it appears as Hercules† and Cacus, although the preciseness of detail narrated by Virgil, Livy, and other writers, has given it quasi-historical rank. Hercules, after his victory over Geryon, stops to rest by the Tiber, and while he is sleeping the three-headed monster, Cacus, steals some of his cattle, dragging them by their tails into his cavern in Mons Avertinus. Their bellowing awakens Hercules, who attacks the cavern, from the mouth of which Cacus vomits flames, and roars as in thunder. But the hero slays him and frees the cattle, a victory which the earlier Romans celebrated with solemn rites at the Ara Maxima. In Greek myth the most familiar examples are the struggles between the sun-god, Apollo, and the storm-dragon, Python, and the deliverance of the Princess Andromeda by Perseus from the sea-monster sent by Poseidon to ravage the land. In the Northern group we have the battle of Siegfried with the Niflungs, or Niblungs, and of Sigurd with the dragon of Fafnir, who guards golden treasures; while, in the Eddor, Thor goes fishing with the giant Hymir, and, baiting his hook with a bull's head, catches the great serpent Midgard. Amongst ourselves, Beowulf, hero of the poem of that name, attacks Grendel, the grim and terrible Jotun that haunts a marsh by the German Ocean (the watery habitat of these monsters is a noticeable common feature), and carries off young and old alike, so that the land is desolated. With mighty grip Beowulf tears him limb from limb, and when, later on, another "winged worm," devourer of fair damsels and hoarder of stolen riches, appears, Beowulf slays him with his enchanted sword.

These brief illustrations would hardly be complete without some reference to our national saint. Opinions differ as to his merits, Gibbon stigmatising him as a fraudulent army contractor,* while the researches of M. Ganneau seek to establish his relation to the Egyptian Horus and Typhon. Be this as it may, the stirring old legend tells how George of Cappadocia delivered the city of Silene from a dragon dwelling in a lake hard by. Nothing that the people could give him satisfied his insatiate maw, and in their despair they cast lots who among their dearest ones should be flung to the dread beast. The lot fell to the king's daughter and she went unflinchingly, like Jephthah's daughter, to her fate. But on the road the hero learns her sad errand, and bidding her fear not, he, making sign of the cross, brandishes his lance, attacks and transfixes the dragon, and leading him into Silene, beheads him in sight of all the people, who, with their king, are baptised to the glory of Him who made Saint George the victor.†

While, however, the myth of Indra and Vritra has in its Western variants remained for the most part a battle between heroes and dragons, the moral element rarely or never obscuring the undoubted physical features, it gave rise among the Iranians, or ancient Persians, to a definite theology, the strange fortunes of which have profoundly affected Christendom. How this came about needs another paper to tell.

* Both "pecuniary" and "fee" are, as established by Grimm's law, from *pecu*. Lat. *pecu-a*, pl. *pecus*, "cattle"; Sansk. *paçu*, "cattle" from *pac*, to fasten (that which is tied up, *i.e.*, domestic cattle). Cf. Skeats's Etymol. Dict. *in loc.*

† Not the same as the Greek Herakles. The similarity of name led the Romans to identify their Hercules, who was a god of boundaries, like Jupiter Terminus, with the Greek hero. *Cacus* is not cognate with Gr. *kakos*, bad, but was originally *Cœcius*, the "blinder" or "darkener."

OUR CHEMISTRY COLUMN.

By WILLIAM JAGO, F.C.S.

SEA SALT.

TAKE a glass of sea-water, set beside it another filled with the purest water to be obtained; observe the two most carefully; to the sight, at least, they present no difference; one might as readily be taken as the other, and emptied at a draught on a hot summer's day, yet all know that while the latter is the most precious boon to a thirsty man, to offer the former would be a cruel mockery, its contents are undrinkable, the water is—salt. Water acts as an almost universal solvent, and as a result of this property, is never found pure in nature; the sea, as the great reservoir into which rivers are continually pouring their contents, acts also as the receptacle of the solid matter they have dissolved from the rocks and moorland over which they have passed in their course. The

* "Decline and Fall," vol. iii., c. xxiii, 171. (Smith's Ed.)

† See Ralston's "Russian Folk Tales," p. 347, for similar Bulgarian legend about St. George.

sun, acting on the ocean's surface, vapourises water only; through the cycle of cloud, mist, and rain, it is again borne to earth, and once more commences its downward flow oceanwards, carrying with it another burden silently stolen from river banks, and as silently leaving its load with the sea as it goes on to repeat its mission in cloud and shower. In this way the sea acquires its characteristic saltness through the gradual transference, by the agency of rivers, of the soluble matter of land to itself. The saltness of the sea is not the result of the solution of one substance alone; although by far the greater part of the solid residue left on evaporating a sample of sea-water to dryness consists of salt proper (common salt or sodium chloride, NaCl of the chemist), there are several other ingredients also present. Among these may be mentioned magnesium chloride and bromide, calcium sulphate and carbonate, besides traces of other substances. The presence of magnesium chloride may be noticed by tasting sea-water; it will be observed that it has, in addition to the simply saline taste of pure salt, a bitter flavour. This is much intensified by evaporating a quantity of the water almost to dryness; the salt, being less soluble, crystallises out, and leaves an intensely bitter solution of the more soluble magnesium chloride. To this solution, to which we shall again refer, the name of *bittern* is given. The quantity of calcium sulphate in sea-water amounts to a little over one part per 1,000, yet, although so small, it is sufficient to produce vast effects in Nature, as when, for instance, through an alteration in the configuration of the land, a portion of the sea is changed into an inland lake and then slowly evaporated; beds of rock-salt are thus formed, interstratified with layers of gypsum, which is but crystallised calcium sulphate. As the substances dissolved in sea-water must necessarily have come from the land, and as the igneous rocks must have furnished the first material to be weathered and ground down into sediment, it is interesting to trace the presence of the same elements in these primary rock masses. Igneous rocks by their decomposition furnish two classes of bodies; those of one of these are insoluble, and comprise sand, which is mostly pure silica and clay—a silicate of alumina; among the soluble bodies are compounds of sodium, potassium, magnesium, and calcium. These are also present in sea-water. The presence of common salt in granite may be easily proved by a striking experiment. Take a few fragments of the rock and crush them to powder in a clean iron mortar, or else on a clean surface, with a hammer, transfer the powder thus obtained to a test-tube, and add distilled water, boil, and pass the solution through a filter-paper. Evaporate a few drops to dryness on a clean glass slip: a sensible residue remains. To another portion add a few drops of silver nitrate solution; the production of a white precipitate of silver chloride proves the presence of a soluble chloride in the rock. Viewed under the microscope, many samples of granite show themselves to be full of minute cavities, in many cases partly filled with a saturated salt solution. Before leaving the historic chemistry of sea-salt, taught us by geology, a very remarkable property of sea-water, as distinguished from fresh water, may be mentioned. Select two glass vessels of similar size and shape (tall gas jars answer admirably), put into each a couple of ounces of dried mud, the finer the better, and fill the one with fresh, the other with salt water; shake them both thoroughly and then set aside. The mud will be deposited as a sediment from the sea-water, leaving the upper liquid clear, in a fraction of the time necessary to effect the same with the fresh water. This is no doubt one reason why many rivers deposit their mud as a delta immediately at their mouths, rather than carry it out and allow it to settle for a much further distance over the sea-bottom.

At one time the extraction of salt from sea-water was carried on largely on the southern shores of England. Although the working of the vast salt deposits of Cheshire has now, with us, superseded this industry, yet in the south of Europe the process is still solely employed. Shallow pools are constructed at high-water mark, the salt-water is allowed to evaporate in them; and, from time to time, as they form, the thin crusts of salt are raked off: these constitute the *bay-salt* of commerce. After as much salt as possible has thus been obtained, the remaining water, or bittern, is employed as a source from which other substances are prepared, the most important of these being bromine. The presence of this peculiar element in sea-water may be proved by the following experiment. Pour some three or four ounces of sea-water in a six or eight-ounce stoppered bottle, and add a few drops of pure sulphuric acid, and then some of a solution of potassium permanganate; the superb violet colour of this latter compound disappears almost immediately, giving place to a deep sherry-colour; at the same time the liquid acquires a most pungent and irritating odour. Notice, too, that the upper part of the bottle is filled with a reddish-tinted vapour. The addition of the potasium permanganate has produced a chemical change in which free bromine has been liberated; the colour and odour are due to the presence of this element in the free state. There is yet another element present in sea-water very similar to bromine, but this exists in the merest traces—its name is iodine. Its extraction is, however, performed for us by certain sea-weeds. These absorb the compound of sodium and iodine, and store it in their tissues; the sea-weed is dried in the sun and afterwards burnt, the sodium iodide can then be dissolved out from the ash by water. The three elements—chlorine, bromine, and iodine—to whose presence in sea-water we have referred, form a most interesting group, to which, from their forming bodies very much like salt, the name of "halogens" has been given. We propose in our next paper to describe some experiments illustrative of their properties, and through these to explain the modes of their extraction from sea-water.

THE FISHERIES EXHIBITION.

NATURAL HISTORY DEPARTMENTS.

BY JOHN ERNEST ADY.

I.

IN his interesting preface to the Natural History Section of the Exhibition, Dr. Francis Day makes the following observations.*

"The naturalist and fish-culturist ought to approach the question from an entirely different point of view; he should ascertain the life-history of all forms of fishes,—not merely such as serve for human food, but also of those which form the sustenance of the more predaceous kinds. He should endeavour to collect reliable information respecting the plants and animals which afford them sustenance and shelter, as well as ascertain what are their enemies or their friends, and what conditions favour the presence or absence of either class. Irrespective of the foregoing, he should consider the relationship of temperature, currents, soils, and the various conditions of the water in which they reside; to their migrations, growth, health, and

* "Official Catalogue, Great International Fisheries Exhibition, London, 1883." 1st Edition, pp. 160, 161.

reproduction. He should also ascertain whether fish are increasing in numbers, decreasing, or if the supply remains unchanged; if the size of those captured is augmenting or lessening; if their condition is better or worse than it was. Should investigations lead him to conclude that fisheries are being unduly depleted, he should carefully note in what families of fish such is occurring, if possible the cause, while in marine forms it is likewise necessary to inquire if fishermen have to go further out to sea to obtain their captures, if the killing powers of their implements have increased, and whether more men are now required to obtain the same amount of fish than was the case a few years previously. Lastly, it may be observed, that unless the investigator is able to distinguish the various species, he may easily imagine that he sees in some small forms, as the solonette (*Solea minuta*), the young of the more valuable kinds, as the common sole (*S. vulgaris*), whereas he is merely examining one sort that is worthless, except as food for the larger kinds."

In these pregnant remarks we become aware of the fact that we have to deal with a subject as vast as the universe itself. Inorganic nature plays a passive part in sheltering the denizens of the deep, and it affords nutriment to a varied vegetation which ofttimes sustains them. The flowering plant brews nectar for the insect which becomes a choice morsel to the finny monster; and man, most cunning of them all, fashions strange imitations to secure the dupe. Interdependence, then, is one of the laws which regulate Dame Nature.

But we cannot here enter into a detailed consideration of everything which bears both directly and indirectly on our subject, lest our pages should prove too formidable; we must rather content ourselves with a glimpse at certain typical examples which may be found in the Exhibition, and serve to illustrate the forms of animated creation.

In the scale of life, plants are popularly regarded as lower types of organisation than animals. A little reflection, however, will convince one that this is but an erroneous view of the case, and that the two kingdoms are, in reality, the opposite developments of a common origin. There exists a multitude of forms, not yet thoroughly understood, which occupy a debateable area in the field of creation.

If a small piece of fresh meat is triturated in water, and the strained liquor permitted to stand in a place accessible to the rays of the sun for two or three days, and if into this fluid a few threads of cotton wool are suspended, they (the threads) will be found, in due course, to be coated over with a glairy-looking deposit. It requires a high power of the microscope to reveal what this jelly-like substance is. Professor Huxley has called it *protoplasm*, or the *physical basis of life*. When magnified about 700 or 1,000 diameters, as in Fig. 1., the slimy mass will

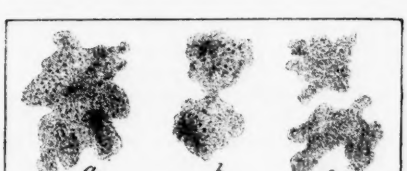


FIG. 1.—*Protamœbæ*, from infusion of meat, × 1,000. *a*, fully grown form; *b*, undergoing fission; *c*, divided.

be seen to move, and soon shows that it is composed of little particles, each endowed with a slowly-creeping motion. The movement consists in the protrusion of rounded lobe-like processes, termed *pseudopodia*,* after which the semi-fluid-like body flows, and thus a movement of a characteristic kind results, and is termed *amœboid*.† Occasionally, one of these little bodies may be observed to divide (Fig. 1, *b*, *c*), and thus to give rise to other individuals; it is then said to reproduce itself by fission.

The sagacious naturalist has termed this little speck of jelly *Protamœba*, and says that it is an animal; this particular *Protamœba*, however, has not been seen to change into anything else. But what about the thousands of other protamœboid creatures! Some of them go a stage further, and are then known as *Amœbæ*, whilst other progress onwards and develop into what are claimed by botanists as plants (*Myxomycetes*). The chief distinction here between vegetable and animal resolves itself into a question of analogy. When the little *Protamœba* passes through a series of stages which simulate those of the undoubted *Pandorina*, as it does in the case of the *Myxomycetes*, it may, with safety, be called a plant. On the other hand, when its jelly-like body becomes faintly parcelled out into an outer firm (ectoplasm) and an inner soft (endoplasm) layer, when it develops a dense internal spherical body (nucleus), ingests matter in extempore stomachs (food-vacuoles), and exhibits, in future stages, a dilatable space (contractile vesicle), which is supposed to pump its fluid contents throughout the substance of the body by a system of obscure canals, then it may probably be an animal. If this so-called animal not only multiplies by fission, but is also observed to become spherical, quiescent, to surround itself with a dense envelope or cyst, and ultimately to burst and liberate a number of small *protamœbæ*, which thereafter go through all the stages mentioned above, we are then fully warranted in assuming that it is an old friend, the proteus animalcule, *Amœba* (Fig. 2), which may

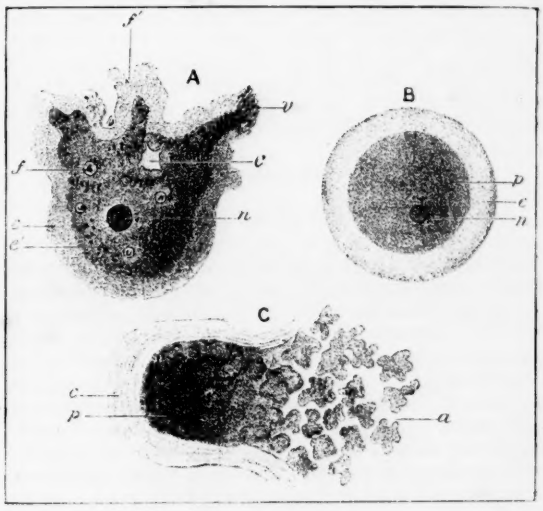


Fig. 2.—Diagrammatic drawings, to show the structure and development of *Amœba*. A. *Amœba princeps*; *v*, villous region; *n*, nucleus with contained nucleolus; *e*, etcoplasm; *e'*, endoplasm; *f*, food vacuole; *f'*, food, a desmid about to be taken in; *c*, contractile vesicle. B. Quiescent Amœba encysted; *c*, envelope or cyst; *n*, nucleus, with nucleolus; *p*, protoplasm. C. Liberated Amœbæ from cyst; *c*, cyst; *p*, protoplasm, now divided into a number of young amœbæ shown emerging at *a*.

* From the Greek, ψεύδής, false; and ποῦς, ποδός, foot.

† So called from first having been observed in *Amœba*, Gr. ἀμοιβή, change.

be seen in activity on Mr. Bolton's table at stand 756, beyond the aquarium.

The question may now be asked, Is *Amœba* a permanent type? Assuredly so; but it very often is only a phase in the life-history of some higher form—*e.g.*, the well-known fresh-water polype (*Hydra*), whose fertilised ovum escapes in the shape of *Amœba*. In this connection there are a large number of problems which yet remain unsolved, and are of great interest, not only to the scientific investigator, but also to those who are concerned with the economies of fish and fishing. It has been stated that the spat of oysters are very often preyed upon by *Amœbæ*, which have been found in large numbers amongst the decaying fish of the culture beds. If this is in reality the case, some attempt should be made to destroy the *Amœbæ;* from analogy, however, we are inclined to suppose that the effect has here been confounded with the cause, and that the *Amœbæ* result from pre-existing germs which find a suitable nursery in the already dead spat. It would, we believe, be as wise to attribute the death of a cat to the larvæ of the blowfly which are invariably associated with its carcass; and we are further supported in our conclusion by the fact that the best hunting-grounds for *Amœbæ* are ponds in which dead cats and dogs abound. Our simple experiment for the manufacture of *Protomœba*, too, is another circumstance in favour of the view that some *Amœbæ*, at all events, are produced from germs which derive their pabulum from decaying animal matter in the presence of water, light, heat, and vegetable growths.

The presence of *Amœba* and kindred forms, such as the remarkable *Protomyxæ* of Hsccckel, in enormous nnmbers in the depths of the sea and in fresh water, render it highly probable that these organisms furnish fish of all kinds with an important part of their food. Evidence is not wanting to show that the minute testaceous *Foraminifera* (the group among which *Amœba* is classed) are by no means despised by even such large fish as the cod, whose stomach is often quite a museum of rare and beautiful forms. We propose, in continuation of this, to furnish our readers with a few pencil sketches of these exquisite organisms, and to link together the manifold variations in their existence which have resulted in phenomena—truly stupendous.

(To be continued.)

The *Scientific American* gives some facts relating to the manufacture of fiddle-strings, and says:—"The name 'catgut,' as applied to the animal fibre strings, is altogether a misnomer. The cat is in nowise responsible for the string, and, much as the fact is to be deplored, the manufacturers of such strings refuse to utilise cats for the supply of their material. That disposes of the last excuse for the existence of the cat. Catgut is of no use to anybody but the cat; hence no consideration of damage to valuable raw material need hereafter stay the hand that hurls the avenging bootjack at the nocturnal serenader on the back fence. Violin strings, and all sorts that come under the general head of 'gut,' are made from the entrails of lambs and cattle, from the delicate threads used for sewing racket-ball covers up to the half-inch thick round belts. After the lamb is seven months old its entrails are no longer fit for making strings for violins; consequently this branch of the manufacture can only be carried on a few months in each year. The only man who now carries it on in America says that he cannot, without tariff protection, compete with the cheap labour of Germany and France, and he is going to give it up."

A GREAT TELESCOPE.*

WE have seen the wonders of the starlit sky through the largest and best refracting telescope in the world; but the wonderful instrument is not destined to remain in America. The most important part of it, the object glass, with the cell that holds it in place, will soon be on its way to the Russian Observatory of Pulkowa, located on the Pulkowa Hills, nine miles south of St. Petersburg, and commanding a fine view of the capital. The Observatory was built and richly endowed by the Czar Nicholas in 1839, and has won high renown on astronomical annals for the work it has already accomplished under its first director, the eminent astronomer Wilhelm Struve, as well as under his son, Otto Struve, who became director in 1864, upon the death of his distinguished father, and still holds the honourable position.

The Russian Government was not satisfied with the capacity and size of the present working force of the Observatory, and determined to have a new refracting telescope constructed which, in mechanism and optic power, should surpass any telescope in existence. The director (Struve) was commissioned to carry out the plan. The most perfect workmanship attainable was to be put in requisition, and Struve chose from all the world, for the execution of the difficult and delicate task, the Messrs. Alvan Clark & Sons, the famous telescope-makers of Cambridgeport, Mass.

Struve came to this country and intrusted to their skilful hands the making of the object-glass, with a diameter of thirty inches, and its cell. The mounting of the great telescope is being made in Hamburg, Germany, by Messrs. Repsold & Sons. The Pulkowa object-glass is four inches larger than that of the Washington telescope, finished in 1873, and seven inches larger than that of the similar instrument recently completed for the Princeton Observatory, both telescopes being the work of the same makers. The arrangements with Messrs. Clark were made in the summer of 1881, and the great objective was completed in October, 1882.

A temporary equatorial stand was erected in the yard of the workshop, in order to test the quality, power, and perfection of the glass. It consists of a pier of solid masonry, to which a tube of sheet-iron, made in three sections, is firmly fixed, with the necessary mounting to secure its movement in the required direction. The object-glass, the eye-pieces, and other appurtenances being then placed in position, the great refractor was ready to show its working power, and to reveal any slight imperfections in the polish or finish that required attention. The precious glass bore the testing process with triumphant success, and is pronounced by the makers to be the best that has left their hands.

But the supremacy of the Russian telescope as the largest of its kind in the world will be of short duration. The same trial mounting will be used by the Messrs. Clark for testing the 36-in. object-glass which they have engaged to make for the Lick Observatory of California.

The pier of the temporary structure is 27 ft. in height; the tube is 45 ft. in length, with an aperture of 40 in. in diameter. Figures, however, give a faint idea of this giant structure. It must be seen looming up under the sky before its huge dimensions can be realised. A view of the heavens through its great eye must be taken before its wondrous light-gathering power can be imagined.

The evening of our observation is intensely cold, but the sky is undimmed by the shadow of a cloud, the atmosphere is free from a breath of moisture. The heavens

* From the *Scientific American*.

present a scene of exceeding beauty as the party of observers take their places under the stars. The last lingering rays of twilight faintly suffuse the west; the new moon, only a day old, holding the old moon in her arms, is nearing the horizon; and the zodiacal light spreads its cone of pale gold high up among the eternal stars. Under the dark dome arching above us the brightest stars and clusters of stellar space look down with friendly eyes, and seem to hang low, as if they would hold communion with mortals. Among them thread the planets Jupiter and Saturn, whose mysterious portals we audacious invaders are seeking to enter this night with necromantic art. Rising from a surface of unbroken snow, and looming up with shadowy indistinctness, the huge telescope seems to pierce the skies, while the observers at its base dwindle to pigmies.

After a short time the instrument is ready for action; its open eye is turned upon the planet Saturn. The serene star, upon which a moment before we had turned our unaided eye, is suddenly transformed into a creation of surpassing beauty. A superb golden sphere, as large as the full moon, lies before us. Saturn is softly cradled in the protecting embrace of his engirdling rings, and seven of his eight moons are visible as bright points on the dark background of the sky. Titan, the largest moon, has a perceptible disc. Every detail of the magnificent and complex Saturnian system is complete. The outer ring, with its faint line of division; the division between the outer and inner rings; the inner or second ring; the third or crepe ring, closely joined to the second; the break on the rings formed by the shadow of the planet; and the soft markings on his disc. Nothing is wanted in the minutest details, and there is but one imperfection in the picture. The definition is not good; the outlines are not clearly defined. The view does not differ greatly in dimensions from that presented by a smaller telescope, but planet and rings are flooded with light of delicious brilliancy and softness. Here lies the advantage of a great telescope. It brings to the eye all the light that enters it, so that, within certain limits, the larger the telescope the larger the amount of light it collects, the more easily visible will faint objects become, and the greater the number of objects before unseen that will be revealed.

Terrestrial colours are muddy in comparison with the celestial hues of liquid gold of the disc and rings, and the creamy tints of the belts that cross the disk with the lightness and grace of scudding cloud-bands. The sphere seems almost to stand upright within the encircling rings, only a small portion of the planet being seen beneath them. We have fallen upon favourable conditions for a view of Saturn, for his rings are opening to their widest extent, his northern declination is increasing, and he is approaching perihelion.

Jupiter is the next object to test the space-annihilating power of the instrument. The Prince of Planets is superb—larger than the full moon, though but little larger than we have seen him many times in a telescope of 8 in. aperture. He is, however, much brighter; and though by no means as magnificent as Saturn, we have the pleasure of feeling that we see him on a much larger scale. He seems so near that we are impelled to put our hands behind the glass and touch him. His broad belts are delicious in colouring, now suffused with pale rose or mottled with soft grey, while shades of purple, brown, and delicate green are interspersed. Never before did we behold the variety of tone and tint, the flood of light we see this night. Never did our giant brother seem so near, so grand in proportions, so symmetrical in equipoise. His four satellites are brightly beaming on his left, and bear testimony to the power of the telescope by presenting disks instead of points. The famous red spot is wanting in the view. We mourn its absence, for, since 1878, its well-known features have become as familiar and firmly fixed as if they were a permanent feature on the planet's disk.

What shall we see next? is the question now discussed, for the extreme cold has congealed the oil, and the monster refuses to move. His eye is turned to the meridian, and no effort will make him swerve one inch to the right or left. In this emergency, a member of the party volunteered to mount to the top of the pier and lubricate with fresh oil the joints of the giant. The plan is successful, and, with many a shriek and groan, the lower end of the tube rises and the upper end falls, until the Cyclopean eye points to the great nebula in Orion.

The little wisp of cloud haze visible to the naked eye is transformed into one of the most glorious visions that ever breaks upon the entranced eye of the observer. The most wonderful nebula the northern sky reveals lies before us, filling the whole field of view, and suffused by a light that never was seen on sea or shore. Now we appreciate the power of the great telescope, the triumph of the optician's art. For definition is of little consequence in observing the shadowy nebula. Light is needed, and light comes.

The delicacy of the celestial glow that pervades the scene is beautiful beyond comparison. The central point of interest is the famous trapezium, consisting of four bright stars and two smaller ones. Around this sextuple group radiate what seem to be the head and branching horns of some huge animal, the trapezium occupying the open mouth, and surrounding a space of sky within which reigns the blackness of darkness. Spiral curves of nebulous haze fill in the field of view, the radiating mass being of a delicate green tint, while dotted over the shadowy haze are many brilliant stars, throwing an element of life into the formless void, and helping to light up this scene of loveliness and grandeur which no pencil may paint nor pen describe. We feel, while with reverent eyes we gaze upon the picture, that we are looking within the eternal gates, and enjoying a glimpse of the glory to be revealed, that "eye hath not seen nor ear heard."

FIRST-COUSIN MARRIAGES.

AT a meeting of the Academy of Medicine in Ireland* (Sub-section of State Medicine), Dr. C. A. Cameron, the President, read a paper on consanguineous marriages in relation to deaf-mutism. He described the practices and prejudices in respect of consanguineous marriages amongst ancient and modern nations, civilised, barbarous, and savage. He next reviewed and criticised the memoirs on the subject of the effects produced by the marriage of cousins. On the whole, the evidence seemed to show the effects were somewhat injurious. The statistics in reference to mutes published in the Irish census reports for 1881 and the previous decennial reports were closely examined by the author. It appears that in Ireland in 1881 there were 5,136 mutes, of whom 135 were the children of first cousins. The author endeavoured to ascertain the proportion of the population who were children of first cousins. He ascertained that amongst nearly 8,000 persons the proportion was only 0·57 per cent., or less than one-fourth of the rate amongst deaf-mutes. As the statistics were in great part collected amongst Protestants, the author believed that there were not in all Ireland one person in 200 the offspring of first cousins, as marriage between persons so related was

* Reported in the *Medical Press*.

very rare among Catholics, who formed three-fourths of the population of Ireland. The general conclusion arrived at was that consanguineous marriages was a cause of deaf-mutism.

The Chairman (Dr. Fitzpatrick) observed that the paper was the most remarkable he had heard at any public meeting for a long period, making it apparently clear to demonstration that the marriages, particularly of first and second cousins, were productive of deaf mutism. In his own long experience he found almost every case of deaf-mutism to be the result of the intermarriage of near relatives. To take an example, he found not only was one child a deaf-mute, and another insane, but the whole family partook of degeneration of the nervous power. They entered early into marriage and never prospered in society. Scrofula, deaf-mutism, insanity, and other characteristics exhibiting weakness of brain and muscular power resulted from those marriages.

Dr. Eustace thought the question must be considered very much from the animal point of view. The human family was at the head of all other animals, so that the question might be elucidated by what took place with other animals, who, according to their anatomy and in many respects, were our relatives. It was well known to all persons who tried to breed first-class animals that close in-and-in breeding resulted in very great deterioration of the species, and also that animals, when left to themselves, did not select their nearest relations for sexual intercourse. That intermarriages were productive of many evils as a general result he held to be a fact. With regard to mental disease, he believed the health of the intellect in the human family depended more largely than they were in the habit of considering on the bodily health or physique, although there were exceptional cases in which very poor specimens of humanity were gifted with brilliant intellect. In the treatment of the insane his leading principle was to get up the bodily health, and as it improved the mind improved.

Dr. Cox mentioned an instance in which two cousins got married. Both were healthy, and without any special indication of disease. The result was, that of the offspring, one, a very fine girl, died of phthisis, another developed symptoms of lung disease, but happily escaped consumption, and a third developed spinal disease. Again, in animals other than the human species, disease was apt to occur in those nearly related; while in the vegetable kingdom, plants of the same kind which were barren were often fertilised by the pollen of others.

Dr. Willis instanced a case he saw some years ago near London, of a sick child whose father and mother were deaf and dumb, and it was through their children, all of whom could speak, he came to a decision about the ailment.

Dr. Wright concurred as to the damage ensuing from the marriage of near relatives, and referred to Darwin's experiment on pigeons, and to the difficulty of keeping a pure breed of poultry, as illustrated by the fate of the bantams brought from the palace of Pekin, and by the destruction of another favourite breed of fowls, the white-crested Polish.

The President replied, pointing out that his statistics were necessarily incomplete and restricted. It would be indispensable to ascertain how many of the whole population were the children of first cousins before drawing a definite conclusion.

Tramways in Japan.—A tramway is now in operation at Tokio, the capital of Japan. The traffic is stated to be making satisfactory progress.

PLEASANT HOURS WITH THE MICROSCOPE.

By Henry J. Slack, F.G.S., F.R.M.S.

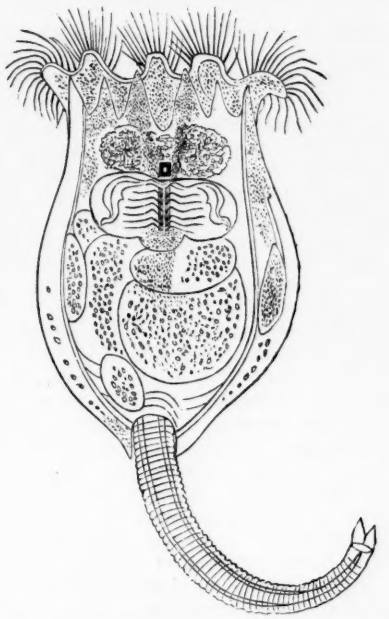
THE present is an excellent time for Rotifer-hunting. A pond, in a sunny situation, covered with a green scum caused by myriads of minute vegetable organisms, is sure to contain several species; while other ponds and quiet river pools, in which various flowering water-plants grow, are likely to be frequented by the tube dwelling species which attach themselves to the stalks or leaves. There are three obvious distinctions amongst groups of rotifers. There are two sorts of free swimmers; to the first of these belongs the Philodines, of which the common rotifer, *R. vulgaris*, is the most abundant. All members of this group are protected by a strong skin, and as it is very elastic, and has its telescope-like joints united by a flexible material, they can execute very curious changes of form. Sometimes one will be nearly globular; at others every joint stretched out, and the creature worm-like in shape, with a conical snout. Suddenly, this snout is withdrawn, and the rotary organs protruded, which work so as to produce the optical illusion of wheels revolving on an axis (Fig. 1.) The second sort

1. Rotifer Vulgaris. A, its so-called gizzard; B, contractile vesicle connected with the water vascular system.

of free swimmers are provided with a carapace, or hard, transparent shell, to which they are organically attached at certain points, but so as to permit their bodies to enjoy considerable freedom of motion inside their armour (Fig. 2). After these may be ranged the householders, or tube-dwellers—a most interesting group (Fig. 3). Their usual plan is to throw off rings of a gelatinous substance. These arranged one upon another, and kept hollow by the motions of the creatures while they are consolidating, form convenient dwellings. One species makes a great advance in construction, and is the architect of the family; this is the *Melicerta ringens*, which is provided with a brick-moulding apparatus, and builds her house by placing brick upon brick in workmanlike fashion. There are also rotifers that dwell in societies, like *Conocchilus*, a mass of gelatinous matter forming their common home.

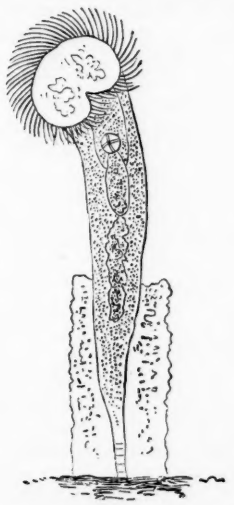
It is well to begin with some general notions of the rotifer tribe, as no one can foresee what is likely to be the result of a few hours' search after them. A few differ very widely from the typical genera, but in all the above-mentioned an apparatus of cilia producing whirlpool currents may be observed, though they do not all exhibit this in the wheel-like shape. The rotifer-hunter should be provided with a wide-mouthed bottle at the end of a

stick. This will catch the free swimmers. A hook at the end of a stick will facilitate pulling out pond weeds, and a small curved knife, instead of the blunt hook, is handy for cutting off portions of myriophyllum, anacharis, or other



2. Brachionus urceolaris, remarkable, amongst other things, for its highly-organised tail, which it flaps like a cat.

plants on which the tube dwellers may have erected their houses. Mr. Baker, in High Holborn, Mr. Stanley, and many other opticians, sell walking-sticks containing a fishing-rod joint to extend their length, and with a handy



3. Œcistes crystallinus.

way of attaching the bottle, hook, or knife. Besides the capturing-bottle, a larger one should be taken to hold the spoil, which a hand-magnifier is usually sufficient to indicate.

In other papers, opportunity will be found for describing in detail some of these interesting creatures. At present we may consider some of the leading peculiarities of the family. Comparative anatomists put them amongst the *Scolecidæ*, a group that includes the intestinal worms. The arrangement is not very satisfactory, as most of the rotifers are superior in organisation to any of these worms in any of their stages; they all, however, agree in possessing a peculiar set of vessels called "a water vascular system," communicating with the exterior, and probably subservient to excretory processes. Female rotifers are furnished with a gullet, a masticating apparatus, commonly called a gizzard, but which in several species can be protruded as a prehensile mouth. They also have a stomach, and an intestine ending in a cloacal opening, except in one genus. All have a nervous system. The larger carapaced sorts show a conspicuous cerebral ganglion, which is not difficult to see in most others, but the ramifications of the nerves are more or less untraceable. They have no blood circulation. Their ciliary apparatus is very complex. Most commonly they bring all the light floating matter around them near their mouth-opening by means of the whirlpools which they excite; but as the observer watches them he will see that they can produce other currents to cause the particles they want to pass down into the gullet, and onwards through the gizzard, while other particles they find unsuitable are hurled away.

Most of them have little red eyes, which glisten like rubies when well lit up. These organs seem to have a cornea and a lens, and sometimes disappear in the adult stage. The alimentary canal is lined with cilia, and in one genus, *asplanchna* (which have no anal aperture), the digestive process is assisted by very strong currents produced by cilia that are conspicuous under high powers.

Male rotifers are scarce, and those of many species have not been discovered. They are only wanted at certain times, and then not for long, so they are not provided with any alimentary apparatus. The females produce a plentiful supply of eggs, which are mostly hatched externally; but in the common rotifer, and some others, the young ones may be seen inside their mothers, and working their tiny gizzards or jaws. Opportunities will occur for describing the structure and ways of individuals of this interesting family, and, meanwhile, the figures now given will help the beginner to recognise some of the most striking forms.

These figures are taken from "Marvels of Pond Life," by permission of Messrs. Groombridge & Sons They are drawn as they are easily seen, and many interesting particulars will be found in the work they belong to.

Time Signalling.—In the annual report of Mr. W. H. M. Christie, astromer royal, he says:—"There has been no case of failure in the automatic drop of the Greenwich timeball. On three days the ball was not raised on account of the violence of the wind. The Deal ball has been dropped automatically at 1 p.m. on every day throughout the year, with the exception of five days on which there was a failure in the telegraphic connection, of one day when the ball was accidentally dropped 4 sec. too soon by telegraph signals, and of fourteen days when the current was weak and the trigger was released by the attendant. On twelve days the ball was not raised because of the violence of the wind. The Westminster clock has maintained its high character, its errors having been under 1 sec. on 66 per cent. of the days of observation, between 1 sec. and 2 sec. on 25 per cent., between 2 sec. and 3 sec. on 6 per cent., and between 3 sec. and 4 sec. on 3 per cent. The error has never exceeded 4 sec."

THE DOLPHIN AT THE BRIGHTON AQUARIUM.

IN a letter to the *Brighton Examiner*, Mr. Henry Lee writes as follows :—By the courteous invitation of the authorities of the Brighton Aquarium, I have paid a visit to the dolphin recently placed in one of the large tanks there. It is a full-grown specimen of the common dolphin (*Delphinus delphis*), and is about 10 ft. in length. It was found, early on Saturday morning last, stranded in Selsea Bay, eight miles from any railway station ; and by means of much toil, care, and skilful treatment, it was brought safely to Brighton by Mr. Lawler, the curator, after being out of water for twenty hours. This is the third species of the whales that have been exhibited in this aquarium. The other two have been the common porpoise (*Phocœna communis*) and Risso's grampus (*Grampus griseus*).

The opportunities of observing closely the habits of the cetacea are so rare, and the average duration of their lives in captivity is so brief, that any one who feels interested in the movements, structure, and mode of life of these great sea-beasts should not lose a chance of improving his acquaintance with them. In this instance, the difference between this dolphin and the porpoises previously seen in the Brighton tanks should be noted. It is of larger size, weighing about half a ton ; its snout, instead of being rounded off like that of the porpoise, is lengthened out in form of a beak, both jaws of which are filled with simple, pinnate teeth ; and the dorsal fin rises much higher, and the tail is rather wider across, than in the common porpoise. Those who have not seen one of these creatures under such favourable circumstances should notice, also, its mode of locomotion. This is effected entirely by an up-and-down motion of the tail (unlike that of fishes, in which the movement of the tail is from side to side, except in the flat fishes), and the flippers, or "paddles," as they have been called, do not contribute to its progress in any way ; they are only used as rudders and poisers. As the water in the tank has been lowered so far as to allow the dolphin to be seen when it rises to the surface of the water, the action of the blow-hole and the absence of all "spouting" should be remarked. In fact, by two minutes' intelligent observation of this interesting animal a grand practical lesson in comparative physiology is to be learned—one a thousand times more impressive than can be obtained from the most careful explanation in print. We have before us a warm-blooded animal of great brain capacity, full of intelligence, breathing atmospheric air by lungs, like ourselves, and the female of which suckles her young one, and attends to it with the greatest maternal affection. This highly organised creature, instead of walking on four legs on land, has to live and move in water ; and, so, its shape is adapted to its necessities, and it is made in the external form of a fish. But it has to breathe air through its lungs, and not the oxygen contained in water through gills. If it were to inhale the air in the ordinary way—through its mouth—the water would enter with it, and choke it. To meet this difficulty, its windpipe is carried up to the top of its head, and is fitted with a valve which allows the exhausted air from the lungs to pass out, and fresh air to be drawn in, whilst it effectually excludes the water.

THE *Moniteur Industriel* (Paris, May 17) says that at the present time, a little over 700 miles of subterranean telegraph lines are actually completed in France. About 1,300 miles more are in course of construction, and will be finished by the end of the year.

Reviews.

SCIENCE AS AN AID TO FAITH.*

BY RICHARD A. PROCTOR.

THIS work is remarkable among works of its kind for fairness of tone. The subject is dealt with almost throughout with a calm gravity well suited to it—at least, as viewed by those for whom the author is writing—those, namely, who regard the Book of Genesis as written by Moses under Divine inspiration. The work is not meant for those who doubt this—or rather (for that is the real position of many men of science referred to in its pages) for those to whom such a view of the Book of Genesis does not present itself as reasonable, except in the very limited sense indicated by Sir George Airy in his little treatise on the Hebrew Scriptures. Occasionally Dr. Cotterill forgets for the moment that Hæckel, Tyndall, Airy, and others occupy this position, and adopts a tone which would only suit them if their criticisms related to a book which they regarded as directly inspired by the Almighty. Thus he finds something amusing in the candour and condescension with which "Professor Ernst Hæckel confers his admiration on "the Jewish lawgiver," apparently not noticing that as Hæckel has not the least trace of any idea that the book of Genesis was an inspired work, there is no more condescension in his recognition of the keen insight of the older writer than there would be, for example, in my dwelling on the success with which Wright, of Durham, anticipated the views of modern astronomers about the structure of the stellar heavens. In like manner, he speaks of Prof. Tyndall's Belfast address as inconsistent with reverence for religious truth, not noticing that the offence of which he accuses Prof. Tyndall is one of which no man can easily be guilty. What a man holds to be religious truth he necessarily respects. Prof. Tyndall may or may not have implied that what Dr. Cotterill regards as religious truth is not so in Prof. Tyndall's eyes ; but even if he did he was not guilty of irreverence for religious truth, whether Dr. Cotterill's views are right or wrong. It sounds, no doubt, to many altogether profane when Sir George Airy writes that the geology of the book of Genesis may be fairly good, but the astronomy is all wrong ; yet there is no more real profanity in such a remark from one to whom the book is simply a curious record of ancient ideas, than there would be in a similar remark applied to passages in the Koran or the Talmud. What Dr. Cotterill might have attacked in Hæckel, Tyndall, and others would have been their reasons—had he known them—for not accepting certain books as being the word of the Almighty. These reasons he probably does not know, because, so far as I know, they have never been published—and, in fact, in no way concern the public. Yet, for those whom he was addressing, Dr. Cotterill might without impropriety—and perhaps with advantage—have dwelt on the evidence which is regarded as establishing the Book of Genesis in the position assigned to it by Jewish and Christian theologians. Doubtless, the difficulty is that those for whom he writes need no evidence on this particular point ; while those men of science for whom he is not writing, have no time to spare for an inquiry in which few of them take any interest, except as it might form part of a chapter in such a work as Tylor's "Primitive Culture."

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* "Does Science aid Faith in regard to Creation?" By the Right Rev. Henry Cotterill, D.D., F.R.S.E., Bishop of Edinburgh. (London : Hodder & Stoughton.)

It is pleasing to find something like justice rendered to the greatest philosopher of the age, the much misunderstood teacher of the best, the most reasonable, and the happiest system of moral philosophy. It is indeed singular—though it ought not to be so—to find the atheist (whom, however, I take to be an almost imaginary being) met with weapons drawn from the armoury of one whom foolish folk regard as the chief of atheists. Those who call themselves atheists, and imagine that they are so, are usefully reminded here that if Herbert Spencer has shown theistic views to be inconceivable, so also has he shown those views to be inconceivable which have been opposed to them. An infinite universe is inconceivable; but the idea of boundaries beyond which there is neither occupied nor unoccupied space is not inconceivable only, but unthinkable. Eternity is inconceivable; a beginning or end of time is unthinkable. In like manner, no mind can conceive the idea of Diety; yet to reject the idea is akin to insanity.

Dr. Cotterill's views about other worlds are interesting. He accepts as reasonable the intermediate theory to which I was led—or rather forced—while writing my little book, "Other Worlds than Ours"; but he thinks that this theory may be held, while yet we may believe that at this present time our earth is the only inhabited world—or, at least, the only world inhabited by reasoning beings. This is doubtless possible, however unlikely. The reasons, however, which have led Dr. Cotterill to try to maintain this opinion are not scientific, but depend on that particular form of religious belief which is his.

The book is carefully and thoughtfully written—evidently after careful study of some of the best modern authorities.

THE HEAVENLY BODIES.*

A BOOK so largely made up of extracts as to show rather what the author has read than what he thinks—though he evidently thinks wrongly on a great number of the subjects he has here dealt with. If his mistakes were limited to his own opinions, little harm would be done; but, misunderstanding what others have written, he assigns wrong opinions to them, and so does them injustice. Thus, he remarks that "Mr. Proctor, in his work on the Moon, shows that supposing the moon had an atmosphere equal to our own, it would, under the small attractive power of the body, extend to a height of twenty-two miles," which is absurd. We also learn that Mr. Proctor "supposes the gas corresponding to the line D_3, in the solar spectrum, is a form of hydrogen, differing from the ordinary forms of that gas as known to us," which, if we know anything of Mr. Proctor's opinions, he does not at all suppose. So with other writers. Then he mixes up his authorities in a way which must be particularly unpleasant to actual students of science. In company with Huggins and Secchi, he quotes the idiocies of Mr. Knapp about the perihelion passages of the planets. Instead of Young or Langley, Secchi, Faye, or Huggins, he takes as his most trustworthy authority on the sun, one who has blundered more about the sun and sun-surrounding space than any one now living.

It will be readily inferred how much weight is to be attached to the opinion of Mr. Miller, that this earth is the only inhabited world—the question to which all his quotations, and such reasoning as he advances, are directed.

* "The Heavenly Bodies; their Nature and Habitability." By William Miller, S.S.C. (London: Hodder & Stoughton.)

THE COMMERCIAL PRODUCTS OF THE SEA.*

IN the author's preface to the first edition of this work, we are informed that it is, in effect, a collection of his papers from the *Art Journal* and his serial publications, the *raison d'être* of which was to supply a handy volume, uniform with his other works, on an important subject, which had hitherto remained unrepresented, by a compact and easily accessible form.

That he has admirably fulfilled his promises may be gathered from even a passing glance at the pages now before us, especially with regard to items of statistical and economic value, which form one of the principal features of the entire volume, and fully warrant its happy title, "The Commercial Products of the Sea." We must congratulate the author on the success which has attended his efforts; success which has induced his publishers to issue a new edition, with the hope that it may prove useful to those concerned with the increasing "interest excited by the International Fisheries Exhibition," and we feel assured that, although such interest often proves but evanescent, the intrinsic value of the work will assert its independence, and find a fitting place on the shelves of every student of commercial economy and natural history who is made aware of its existence.

In plan the work is well arranged. The general introduction opens with a brief discourse upon the importance of marine products, the uses of animals, &c., and the only objection we can make with regard to this is, that the biological terminology adopted is somewhat loosely displayed, and is not always accurate. As an example of this we may give one quotation from pp. 2, 3, where the author says:—

> The animals are among the mightiest and among the smallest. There are swimming beasts, as whales, seals, and walruses; there are fishes of various kinds and sizes, crustaceans, soft or jelly fishes, the molluscs, down to those creatures resembling live plants—the zoophytes or corallines, which partake of the qualities of plant, animal, and mammal.

Here the molluscs, instead of being placed in immediate descending series after the fishes, are made to separate the jelly fishes from their relatives the zoophytes. Again, the term "corallines" is used in its obsolete sense to signify the *Polyzoa*, whose affinities with the molluscs on the one hand, and the worms on the other, are entirely disregarded when they are linked with the zoophytes, which are strangely said to "partake of the qualities of plant, animal, and *mammal*," whereas the biologist now understands by the term "corralines" a genus of calcareous sea-weeds belonging to the *Florideæ*.

The rest of the introduction is excellent in the statistical and other data which it furnishes. We would, however, have liked to have seen a little more concerning the fisheries of India, which are here dispatched in a couple of lines, eked out by a short stanza from Milton. We urge this because the records of Indian fisheries are far from scanty, and are most readily accessible.†

There is yet another suggestion which we would offer in this place. Although it may be argued in justification of the plan adopted, that it is a prevalent custom in English literature *not* to note the sources of the information which has been collated, it is a fact to be deplored rather than

* "The Commercial Products of the Sea; or, Marine Contributions to Food, Industry, and Art." By P. L. Simmonds. New and Cheaper Edition, with Thirty-two Illustrations. 8vo, pp. 484. (London: Griffith & Farran, St. Paul's-churchyard. 1883.)

† See Dr. Francis Day's Introduction, Official Catalogue, International Fisheries Exhibition, London, 1883, 1st edition, pp. 260 *et sequentes*.

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defended, especially when such a good example is afforded to us in this particular by our Continental contemporaries.

The first part of the work deals with "The Food Products obtained from the Sea." Scope is here given for a vast amount of information respecting the various kinds of fish and fisheries, the methods of their preparation for immediate use or for preservation, and a fund of literary lore about fish. Nor are we disappointed; for we recognise at once the master's hand in the judicious display of facts set before us. There is a degree of novelty and unusual interest in the chapters devoted to the essentially eastern trepang and squid fisheries, whilst the oysters and their allies demand, and have received, a fair share of attention.

The second portion, entitled "Marine Contributions to Industry," occupies an extent of 197 pages, and includes most of the engravings which are contained in the volume, all of which are well executed; whilst some, more notably those at pp. 156, 169, and 187, are really artistic. A brief introduction is followed by three chapters on sponges; their place in nature is commented on, the modes of procuring and preparing them are fully described, and their marketable values are carefully noted. Some of the more beautiful hexactinellid sponges, such as *Euplectella* and *Holtenia*, also, are neatly figured. At p. 182 the following sentences are worthy of remark, as illustrative of the value of scientific experiment to commercial enterprise:—

"During the past few years, Dr. Oscar Schmidt, Professor of Zoology at the University of Grätz, has employed several weeks of the early summer in artificially producing and rearing the bath-sponge. His labours have met with such success that his system has been adopted by the Austrian Government, and is now carried on on the coast of Dalmatia.

"It has for some time been a well-known fact that several families of zoophytes have such great powers of reproduction, that a portion of one will grow and form on an entirely new body. This property has been taken advantage of by Dr. Schmidt, his process being to cut the sponge into pieces, fasten each portion to a pile, and immerse it in the sea. The pieces then grow, and eventually from each one a spherical sponge is obtained. According to the estimates of Dr. Schmidt, a small piece of sponge at the end of three years will represent a value of 5d. The total cost of raising 4,000 sponges, including the interest on the expended capital for three years, is estimated at £8. 8s., and the income at about £16, leaving, therefore, a net profit of nearly £8. There is no doubt but that the practice of this branch of industry will be the means of considerable benefit to the inhabitants of the Idrian and Dalmatian coasts."

We would fain linger over pages such as these are, but must content ourselves with merely remarking that the products of marine mammals, fish, molluscs, seaweeds, and even salt, are all carefully included in these chapters.

The third section is devoted to "Marine Contributions to Art," and in this, as in the other parts, the author has utilised his space with the highest degree of excellence. Tortoiseshell and turtles, mother-of-pearl and pearl fisheries, corals and amber, successively considered, bring the work to an appropriate close. Lastly, there is a fairly copious index appended.

A New Electric Cancelling Stamp.—This instrument has been invented by Monsieur J. Châtenet, and is designed by him to supersede the present Post-office cancelling stamps. It is of the same size as the ordinary ones, and the top of the handle is connected by means of ordinary insulated wire with the two poles of a battery. The circuit is closed by the contact of two metal plates on the face of which is a zig-zag platinum wire. Upon the postage-stamps being struck in the ordinary way, contact is made, and the platinum wire becomes instantly red-hot. This burns the surface of the postage-stamps in such a manner as to render it impossible to erase the marks, while doing no injury either to the envelope or its contents.

Editorial Gossip.

We have seen and heard Mrs. King lecturing on and in the divided skirt; and we venture to express the most confident opinion on the utter futility of any attempt to persuade ladies to adopt the style of dress she advocates. It is, to all intents and purposes, Bloomerism over again; and the Bloomer costume failed egregiously. It was bound to fail; and so is the new dress—not because it is *outré*, for there is no dress, however preposterous, which fashion could not force women to wear (witness the development of crinolines, tie-backs, and the present fantail-pigeon style), but because it attracts notice to women as running counter to the fashion. Sensible women so array themselves, whatever absurdities may be in fashion, as not to appear absurd, either in following the fashion to its full absurdity, or in being markedly out of the fashion. Feminine idiots in the days of crinoline made themselves known by the fullness of their crinoline development; in the days of tie-backs by the exposure of contours (either their own or Parisian), usually concealed by more flowing drapery, and at the present day by Parisian protuberances, pectoral, and otherwise than pectoral, unknown to nature, save among fancy pigeons; ladies are able to be in the fashion at all times, yet reasonably attired. Now the divided skirt in the obtrusive form advocated by the reformers, is neither idiotic nor indecent like many of the developments of fashion among races essentially inartistic; on the contrary, regarded merely as clothing, and not as adornment, it is sensible and seemly; but it is staringly out of the fashion. It attracts notice, a serious matter wherever louts and boobies, 'Arrys and 'Arriets are many. A few strong-minded—but not therefore the wisest—women, may try the new dress; some others neither wise nor strong-minded, but pleased to attract notice in any way, may adopt it; but it needs no prophet to know that women generally, wise enough to know that street-staring, and the coarse comments of the vulgar, are neither to be invited nor despised (however contemptible in themselves) as of no account, will not expose themselves to unpleasantness even for the sake of the undoubted advantages which the proposed costume presents.

Mrs. King considers that harm is done to the cause she advocates by those ladies who wear the divided skirt but conceal it so that no one knows they are wearing it. She mistakes. Round by the road may be a longer way than through the hedge, but it may be much the better way even where the hedge can be broken through. The way she recommends is through the hedge; but there is no getting through. She thinks the way by the road does not lead to the desired goal; but those who have tried it find that it does; it is also an easy way and a pleasant way.

We are sorry to see the *British Workman*, usually rather obtrusively goody-goody in tone, becoming, to all appearance, an advocate of steady drinking. So, at least, we infer from the only story we have read in No. 342. It is called "A Ship Wrecked by One Glass." We must confess we read it in the hope of finding some such amusement as one derives from the famous temperance stories in "Pickwick." Imagine, then, the pain with which we found that the wreck of the ship is ascribed to a too rigid teetotalism. "My brother," says the narrator, "was to stand watch. The seamen prevailed on him to take one glass to help him to perform his duties, but, *being unaccustomed to liquor*, he

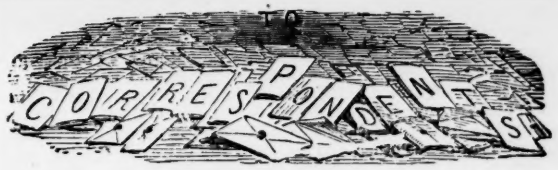
fell asleep, and in the night I awoke to find my vessel a wreck." Truly, an awful warning!

THE Chess Tournament, as we write, is nearly over. It is not clear who will take the second, third, and fourth prizes; but it is certain that Zukertort will take the first. And what a record he has! In no former chess tourney among the great masters has anyone gone ahead of all the rest as Zukertort has here. It may be urged that tournaments are not the best way to test chess strength. A match between Zukertort and Steinitz, for instance, would be the only just way of showing which is the stronger player. Possibly, though even so, it is clear that a particular quality of chess strength is better indicated by the tourney than by the tilt, by combat among many than by jousts between two. "It is better, though scarce easier" (or to that effect), says Wamba the Witless, "to be the best man of twenty than the best man of two," a remark whose point was not fully appreciated by Athelstane the Unready. Zukertort has achieved the harder task; even should he fail in the easier, he would still hold the tourney championship.

OUR daily papers will shortly cease to record the jousts of the chess masters. We must confess to a sense of relief. For truly some of the notes and comments have been perplexing. Thus in the *Times* we read some time back that though Mackenzie and English are strong players, *yet* the game between them ended in a draw. A day or two later we were told that Mr. Skipworth had been prevented from Castling, and *thus* had to submit to the loss of either a Queen or a Rook. Yet again, Steinitz played Pawn to K Kt's 4th, and *therefore* had no time to Castle. Then we had the moves in which Blackburn mated Mortimer, without the position from which the process started; a diagram showing how a game stood after Black's 52nd move with the Black King left in check, and other rather odd chess nuts.

CHESS becomes less and less of a home game as it becomes more and more of a profession. The clubs started and maintained to encourage chess have also been, we believe, the bane of chess as a home game. Just as home whist is decaying (though that is little loss, perhaps, for home whist is usually not worth playing); as club whist extends, so home chess is gradually dying out. The good players are drawn away to clubs; and when they do play in the drawing-room, they do not play (as a rule) for love of chess, but to show how weaklings can be crushed.

CERTAINLY, home chess, like home whist, is apt to be an uninteresting game for strong players. The weak know nothing of their weakness, and would be offended if odds were offered. To win against them affords no chess pleasure. To leave pieces *en prise* becomes too obviously condescending. The only way to bring on a fight is to get into difficulties by moves not obviously meant for that purpose, and then to struggle out of them again (if possible), which often affords excellent practice. But there should be a rule that, after winning three games in succession, a player should be entitled to give (not merely to offer) either such odds as he may choose, or certain definitely advancing odds for each triple victory, the odds-taker being entitled to give back the odds, or the last advance in odds, when he has secured three successive games. The steps in ordinary home play might be the Knight, the Rook, two minor pieces, Rook and Knight, and the Queen—for, in home play, Pawn and move, and Pawn and two moves, are not desirable odds.



"Let Knowledge grow from more to more."—ALFRED TENNYSON.

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LETTERS RECEIVED AND SHORT ANSWERS.

[Our "Letters to the Editor" are unavoidably "crowded out."]

GEOLOGIST wishes to know who are the publishers of Mr. Beete Juke's "Manual of Geology."—J. H. A. O. Thanks, but already provided.—G. HARDINGHAM. I was myself the author of the article to which you refer. The Star-drift spoken of is not a drift of the whole universe, but of groups of stars in different directions. Other question referred to Mr. Slingo.—W. H. M. ASKEW. Thanks; glad to hear the system has suited you so well. I can quite understand that many try it with something like the same idea as the country joskin had about the spectacles in the well-known story, "Helps to Read."—W. W. B. Very glad to have your opinion on the Loisette system. Your friend entirely misapprehended my remark, which neither implied doubts about the system, nor any feeling as to M. Loisette's perfectly legitimate use of my name. I simply called attention to the circumstance that, as indeed M. Loisette showed, I had not myself any personal knowledge of the system. I hope before long to avail myself of the opportunity, long since offered me by M. Loisette, of examining into the system personally.—A. G. MCCALLUM. Thanks; but I fear my opinion on questions metaphysical is of no value. Your Trinity—time, space, and matter—appears to me rather lopsided. Why should not "motion" have a place?—THOS. KIMBER. Thanks; I should be glad to make use of the papers you kindly offer if each of the fifteen or sixteen articles were not more than, say, 1½ or 2 cols. in length.—A. M. M. Thanks; the series might conveniently follow the one now commenced in that column.—PHILISTINE. Granted readily that a drawing-room dress and an out-door exercise dress should differ. But you forget that apart from the nuisance of occasional complete changes of attire, the advocates of what may be called the reasonable divided skirt—that is, the divided skirt concealed by light overskirt—claim for it superiority in just the points which you name—warmth and convenience indoors. Again, do heavy inside skirts "add grace and dignity to the figure?" So far as my own observations extend, the reverse is the case. They take away all grace (unless you admire the movement called the "skirt-kick"), and the dignity they give is akin to that which characterizes the movements of a hobbled cow. I do not myself interfere in the slightest degree with the ladies of my household in such matters; but I must confess that my eyes have become now so used to the easier and more lissome movements following the disuse of corsets and heavy underskirting, that I should be very sorry to see again the heavier movements and the somewhat entangled gait of former times.—W. A. ANDERSON. I forget at this moment (and am away from library for reference) in which of De Quincey's works Richter's dream occurs. You will find the reference in the index to his complete works.—F. M. LUPTON, J. HARGREAVE, AND MANY OTHERS. It is quite impossible to answer through the post the hundreds of letters reaching me on the subject of the divided skirt.—T. J. DEWAR. Thanks for illustration of integral calculus without cymbols. Such methods are to be classified in Newton's lemmas, and would only be suitable here if presented systematically. On the other subject, you should note that letters are not "articles."—J. P. notes that in other accounts of the Archer Fish a distance of five or six inches, instead of a mètre and a half, is indicated as his range of shooting, but Brehm refers to a larger species than the one usually kept in vessels of water to amuse people by its skill in shooting.—L. M. G. B.

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The satellites of Jupiter are always spoken of by astronomers by their numbers, in the order of their distance from Jupiter. It would be well if the same were done with Saturn's. I cannot give you all the names, being away from my books, and never using the names myself, except in the case of Japetus, Hyperion, and Titan, the 8th, 7th, and 6th of Saturn's satellites.—J. BROWN. The heat would be greater, for that side of any object exposed to the sun, much less for the other, and therefore the extremes greater—as in case of the moon, the temperature of whose surface varies some 500 degrees (Fahrenheit).

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By RICHARD A. PROCTOR.

ANALYSIS AND SYNTHESIS.

THERE are two general modes of treatment applicable to problems, termed, conventionally, the *synthetical* and the *analytical*, or *synthesis* and *analysis*. In the former, we study what is given and work up to what is sought; in the latter, we examine what is sought and work back to what is given. I am not concerned here with the correct applicability of the names synthesis and analysis to these processes, and shall therefore content myself with discussing the processes themselves under the names usually given to them.

It is a mistake to suppose that, as some have asserted, *analysis* is the method always employed—consciously or unconsciously—in the solution of problems. Of course, we are compelled to consider what it is we have to do or prove, and thus far the analytical method cannot but enter into our processes. But in the solution of a problem, we may proceed, as may be most convenient, by either the synthetical or the analytical process, or—which in complex problems is far more commonly the case—by an alternation of both methods. As an illustration of my meaning, I may compare geometrical problems to those examples in algebra, trigonometry, &c., in which we have to establish the identity of two expressions. In such cases we may either take one expression, and try to work it into the same form as the other, or *vice versâ*, we may select the latter to work upon, or—which is the surer process—we may work both down to a common form.

However, it will be better to select a few examples of geometrical problems, and to exhibit the application of different processes to them, than to discuss general rules. I begin with very simple examples.

Suppose we have given to us the following deduction :—

Ex. 1.—*The line A B (Fig. 6), is bisected in C, and C D is drawn at right angles to A B. From any point E in C D lines are drawn to A and B. Show that E A is equal to E B.*

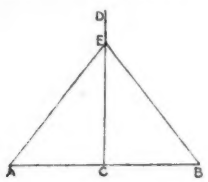


Fig. 6.

Having constructed a figure in accordance with these data, we go over the data thus: we have A C equal to C B, and C E at right angles to A B. We remember, also, that we have to prove that A E is equal to E B. Now, we cannot fail to see that the data involve the equality of the triangles, A C E, C E B, by Euc. I., 4, and therefore that A E *is* equal to E B. This solution is synthetical, notwithstanding the prior reference to the relation which has to be established. For we proceed from the data—A C, C E, equal to B E, C E, and the included angles equal—to the equality of the triangles, A C E, B C E, in all respects, and thence to the equality of A E, E B. In the analytical solution we should argue thus :—We have to show that A E is equal to E B. Now, *if* A E is equal to E B, then since A C, C E are respectively equal to B C, C E, the angles A C E and B C E will be equal (Euc. I., 8); but these angles *are* equal, being right angles; hence we are led to reverse the steps as a *probable* method of solving our problem; and, on trial, we find that the proof of the equality of A E, E B, is complete by this method. We shall presently see that the mere fact of obtaining by the analytical method a result corresponding to certain data of a proposition is no certain test that the problem is correct; and I will at once show that it is no certain proof that the reversal of the process will give at once a satisfactory solution of a problem.

Suppose that we have given to us A C equal to C B, and the angle C A E equal to the angle C B E, and that we have to show from these data that C E is at right angles to A B. We proceed analytically thus: *If* C E is at right angles to A B, then A C, C E being equal, respectively, to B C, C E, the triangles A C E, B C E are equal in all respects; therefore the angle C A E will be equal to the angle C B E. Now, these angles *are* equal; therefore we might expect the reversal of the process to lead at once to the solution of our problem. This, however, is not the case—we have A C, C E equal to B C, C E, and the angles C A E, C B E *opposite* to the common side, C E, equal to each other; but there is no proposition in Euclid which enables us to assert from these data that the triangles C A E and B A E are equal in all respects.

Of course, there is no difficulty in the above problem. The equality of the angles, C A E and C B E, give us immediately A E equal to E B (Euc. I. 6), and thence the equality of the triangles, A C E, B C E, follows at once. But it is well to notice that analysis may lead to a result included in our data which yet does not involve the immediate solution of our problem.

Let us take next a less obvious proposition :—

Ex. 2—*In the Fig. to Euc. I., 5 (Fig. 7), if B G, C F intersect in H, show that A H bisects the angle B A C.*

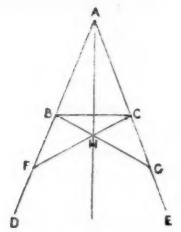


Fig. 7.

Let us go over our data :—We have A B equal to A C, the angle A B C equal to the angle BCA, and also (see the proof of Euc. I., 5), the angle A B G equal to the angle A C F, and the angle G B C equal to the angle BCF. There are other relations which seem unlikely to aid us, so we content ourselves with these. Remembering that we have to prove the equality of the angles, B A H and C A H, we are at once led to notice that our data point to the equality of the triangles, H B A and H C A. For we have the angle A B H equal to the angle A C H, and also A B, A H, equal to CA, AH, respectively. But these relations are not sufficient. Seeing, however, the probability that the solution of our problem lies in this particular direction, we search for some new equality in the elements of the triangle, A B H, C A H. Can we, for instance, show that the angle A H B is equal to the angle A H C? This seems no easier than to establish the equality of the angles, H A B, H A C. Can we, then, prove the equality of the sides, H B, H C? This would involve the equality of the angles, H B C, H C B (Euc. I., 6); and this is one of our data. Hence we see our way at once to the solution of the problem, which runs thus :—

Since the angle H B C is equal to the angle H C B, H B is equal to H C. Hence in the triangles B A H, C A H, we have B A, A H equal to C A, A H, each to each, and the base B H equal to the base C H. Therefore the angle B A H is equal to the angle C A H. (Euc. I., 8.)

It will be noticed that the reasoning from which this solution is obtained is partly synthetical and partly analytical. We apply our data to obtain a result which very nearly gives us what we want; then we inquire analytically how the missing link is to be supplied; and finally, having seen our way to the solution, we run over such portions of our reasoning as are required for the complete proof of the proposition. The mental process is, of course, considerably longer than the solution which results from it—the mind runs rapidly over the elements given and required, selecting and rejecting this or that relation until the path to the complete solution has been traced out. I have only followed one such process of reasoning—that which seems to me most natural. Others might readily be conceived. Thus the equality of the lines A F, A G, and the angles A F C, A G B (see the proof of Euc. I., 5) might occur as the most obvious data for selection. It would, then, be seen that before we can establish the equality of the triangles, F A H, G A H, we must prove that F H is equal to H G; but we know that F C is equal to B G; there-

fore, we must prove that the remainder, H C, is equal to the remainder, H B. This requires the equality of the angles, H B C, H C B. We know these angles to be equal; therefore, H C is equal to H B, and thence F H to H G; and, since A F, A H are equal to G A, A H, the angle F A H is equal to the angle G A H. It is probable, however, that the geometrician's being led, in *this* way, to the equality of H B and H C, would not retrace the steps he had followed, but would immediately notice the shorter proof depending on the equality of B A, A H to C A, A H respectively.

Thus we gather an important rule. Having tracked out, analytically or synthetically, a complete proof of a proposition, it is well before writing down the solution to notice whether the relations which have presented themselves in the process of reasoning suggest a shorter proof, or whether any of the steps of the reasoning may be omitted, or so varied as to be reduced in number. The value of a proof is, of course, much enhanced by brevity and conciseness.

Our Chess Column.

By Mephisto.

THE TOURNAMENT.

With this interesting game, played 11th June, Zukertort won the first prize.

QUEEN'S PAWN OPENING.

White. Zukertort.	Black. Blackburne.	White. Zukertort.	Black. Blackburne.
1. P to Q4	P to K3	22. Kt to K5	P to B3
2. Kt to KB3	Kt to KB3	23. P to B6 (*d*)	R to B2
3. P to K3	P to Q4	24. Q to Q2	P takes Kt
4. B to Q3	B to K2	25. Q takes Kt (*e*)	Q to B sq.
5. Castles.	Castles.	26. B takes P	R to B2 (*f*)
6. P to QKt3	P to B4	27. B takes Kt	Q takes B
7. B to Kt2	Kt to B3	28. P to B7	Q to B sq.
8. QKt to Q2	P takes P (*a*)	29. Q takes RP (*g*)	P to K4
9. P takes P	P to QKt3	30. R to B5	P to K5
10. P to B4	B to R3 (*b*)	31. R to Kt5	R (B2) to B sq.
11. R to K sq.	R to B sq.	32. R to Kt8	Q to Q2
12. R to QB sq.	Kt to R4	33. R takes R	R takes R
13. Kt to K5	B to Kt5	34. Q to R4 (*h*)	Q takes Q
14. P to B5 (*c*)	B takes B	35. P takes Q	R to QB sq.
15. Kt takes B	B takes Kt	36. P takes P	P takes P
16. Q takes B	Kt to K5	37. K to B2	K to B2
17. Q to K3	R to K sq.	38. K to K3	K to K3
18. P to B3	Kt to KB3	39. K takes P	P to Kt3
19. R to B2	Kt to Q2	40. R to B6 (ch)	K to Q2
20. KR to B sq.	P takes P	41. K to Q5	Resigns.
21. P takes P	Kt to Kt sq.		

NOTES.

(*a*) An early exchange of Pawns is disadvantageous for the second player.

(*b*) It seems that the attack by this and the following moves against the QBP does not yield the second player any advantage. English likewise came to grief over it in his game with Zukertort.

(*c*) Good play, it produces a decided superiority of position on the Q side.

(*d*) Taking advantage of the position in masterly style.

(*e*) Playing the combination with unerring accuracy, White recovers the KP with an increased attack.

(*f*) If Black plays R takes P. 27. R takes R, Kt takes R. 28. Q to R4, and he loses a piece.

(*g*) Which practically decides the game.

(*h*) Taking it easy! Q to Kt7 would have been more chessy.

The week's play has been productive of some fine specimens of chess skill, and some surprising—nay, we may almost say marvellous—results. Zukertort met Tschigorin on Wednesday to decide the draw pending between them. Tschigorin opened with the Evans' Gambit, which he played with triumphal success against Steinitz. The superior knowledge and tact in the conduct of opening which Zukertort has shown all along, rightly caused him to refuse the Evans (by B to Kt 3) to a player whose forte is originality. Zukertort won. Curiosity was almost raised to excitement on Thursday, when Zukertort had to meet Steinitz. Although Zukertort was too far advanced to stand in fear of a defeat, nevertheless more than usual interest was attached to this game between the hero of the past and the champion of the future. Steinitz played the Ruy Lopez. He attacked his opponent in somewhat wild fashion, and obtained apparently a strong game, but Zuckertort, rallying, dispelled White's forces on the Q's side, and himself got a Pawn advanced to B 7. Steinitz effected an injudicious exchange of Queens, which enabled Zukertort to win a very hard-fought game in ninety moves. Friday, Zukertort drew with Winawer, but on the Saturday he won against the same opponent one of the best-fought games in the tournament, in which Winawer showed himself at his best; in the end he had a clear draw in hand, but missed it. Monday, again, will be a red-letter day in the annals of the tournament. Zukertort played Blackburne. After about an hour's play it was already apparent that the master would continue his victorious career, and at about 3.30 Blackburne was beaten in a smart but well-fought game, which we give above. With that creditable victory Zukertort has absolutely won the first prize, as will be seen from the table below, from which the final chances of the players in this great contest may be estimated.

Steinitz beat English, Sellman, and Mortimer, and on Monday he drew with Rosenthal, having a fair chance for second honours. Blackburne, since our last report, has only won one game, and drawn with Rosenthal. Mason, who has considerably fallen off, has also only scored one against Bird and lost one against Mackenzie. Worse luck befell Winawer, who lost four games in succession to Rosenthal, Noa, Zukertort, and English, almost losing his chance for a place. Rosenthal continues to do well; he has not lost a game. He won against Winawer, and drew against Mackenzie, Blackburne, and Steinitz.

Tuesday, June 12.—Steinitz played Mason, who adopted the French Defence, and drew; Blackburne beat Sellman; Winawer beat Mortimer; English drew with Tschigorin; Noa beat Bird, although the latter at one time had a won game. Zukertort defended the Ruy Lopez against Rosenthal. The latter obtained a slight superiority, but ultimately had to yield to the victor. The following is the position of the players after Tuesday's play:—

	Has won.	Still to play.		Has won.	Still to play.
Zukertort	22	3	Mackenzie	12	5
Steinitz	15	5	Bird	11	3
Blackburne	14½	5	Winawer	11	4
Rosenthal	12	7	Noa	9½	4
Tschigorin	13	4	Sellman	5½	4
Mason	12½	5	Mortimer	1	3
English	12	5	Skipworth	3 retired.	

THE VIZAYANAGARAM TOURNAMENT.

It will be remembered that this second tournament, for which the Maharajah of Vizayanagaram provided the prize money of £200, began simultaneously with the chief tournament on April 26. As might have been expected, the greater and more important contest prevented the Chess world from giving the attention and interest to the second tournament, which otherwise it would have readily bestowed upon it. Twenty-six players entered the list, and the prizes, five in number, amounted to the respectable total of £200. To this sum £40 was added at the conclusion of the tournament, divided into four prizes. The tournament came to a final conclusion on the 6th inst., when the last adjourned game was played.

When the contest began there were two lots of players, one for day and evening play, the other for evening play only. But this rule was soon relaxed by some more active spirits, who wished to do battle with each other whenever they had leisure time. The committee being much engaged with the arrangements for the major tourney, gave the minor lights great liberty of action. The result being that some of the games degenerated into off-hand play.

Nevertheless, some very good games were produced, and some players have come out of this tournament very much improved both in play and reputation. Mr. Gunsberg started well until he got defeated in a game undertaken out of time and turn with the Rev. Mr. Newham. The next player who attracted attention by his steady progress and good play was Mr. Fisher, who had not lost a game when he scored fourteen, and had beaten MacDonnell and some of the stronger players. He lost his first game to Gunsberg. In the meantime, Herr von Bardeleben was quietly working his way upwards, not losing a single game, and playing very steadily. The Rev. Mr. Ranken also played remarkably well, winning every game, and gained for himself the *sobriquet* of the "Invincible." We may mention that Mr. Ranken took part in the International Tournament of 1851. Some of the other players had also done well, but the confidence of the public rested with the above four players.

The second half of the Tournament witnessed some change in the position of the favourites. Herr von Bardeleben clearly proved his

superiority by only interrupting his score by draws, and especially after his beating Fisher and drawing with Gunsberg, his position as first prize winner seemed well secured. Mr. Gunsberg, who lost to Messrs. MacDonnell and Minchin, resigned second place to Fisher by suffering another defeat at the hands of Mr. Gattie, a player of great ability, who, curiously enough, although not scoring high himself, was the only man who managed to defeat Bardeleben; he also won of Ranken. The latter broke down in the second half of the Tournament, losing several games, probably through physical exhaustion. The Rev. Mr. MacDonnell, who had not been doing well at first, played with increased attention and strength in the second half of the Tournament. Mr. Gunsberg played Mr. Lee in a careless and haphazard fashion, out of time and turn, and, owing to some differences, this game was scored against both players, thus allowing the Rev. Mr. MacDonnell to take third place.

OFFICIAL SCORE OF THE PRIZE WINNERS IN THE VIZAYANAGARAM TOURNAMENT.

	Bardeleben.	Fisher.	MacDonnell.	Gunsberg.	Gossip.	Ranken.	Lambert.	Piper.	Lee.	Benima.	Dudley.	Ensor.	Felvret.	Gattie.	Hunter.	Lindsay.	Lord.	Minchin.	Mundell.	Newham.	Pilkington.	Puller.	Rabson.	Vansittart.	Vyse.	West.	Total.
Bardlben.	—	1	1	½	1	½	½	1	1	1	1	1	1	0	1	1	½	1	1	1	1	1	1	1	½	1	21½
Fisher ...	0	—	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	½	1	1	1	1	1	1	1	1	20½
McDnell.	0	0	—	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	½	1	19½
Gunsberg	½	1	0	—	1	½	1	1	0	1	1	1	1	0	1	1	1	0	1	0	1	1	1	1	1	1	19
Gossip	0	0	1	0	—	1	0	½	1	1	½	1	½	½	1	0	1	1	1	1	1	1	1	1	½	1	17½
Ranken	½	1	1	½	0	—	½	1	0	0	1	1	1	0	1	1	0	1	1	½	1	1	1	½	1	1	17½
Lambert	½	0	0	0	1	½	—	0	1	1	0	1	1	1	½	1	0	1	1	1	1	1	1	1	1	1	16½
Piper.....	0	1	0	0	½	0	1	—	0	1	1	1	1	1	½	1	½	0	1	1	1	1	1	0	½	1	16
Lee	0	0	0	0	0	1	1	1	—	1	1	1	½	0	1	1	1	0	1	1	1	1	1	0	1	1	15½

The prizes were of the value of: 1, £60; 2, £50; 3, £40; 4, £30; 5, £20; 6, £15; 7, £10; 8, £8; 9, £7. Messrs. Gossip and Ranken divided the fifth and sixth prize.

Our readers will be able to judge more correctly of the merits and style of the players by the following table:—

First.	...Bardeleben	...won 19	...drawn 5	...lost 1		
Second.	...Fisher	,, 20	,, 1	,, 4		
Third.	...MacDonnell	,, 19	,, 1	,, 5		
Fourth.	...Gunsberg	,, 18	,, 2	,, 4*		
Fifth	.....Gossip	,, 15	,, 5	,, 5		
Sixth.	...Ranken	,, 15	,, 5	,, 5		
Seventh.	Lambert	,, 15	,, 3	,, 7		
Eighth.	...Piper	,, 14	,, 4	,, 7		
Ninth.	...Lee	,, 15	,, 1	,, 8*		

* And lost 1 by forfeit.

We also give the following analytical table, showing the play amongst the nine Prize winners only (!), independent of the score of the weaker competitors. Some very curious results are obtained, clearly showing that there are qualities besides strength of play which may somewhat materially effect the position and chances of a player in a tournament.

		Bardeleben	Fisher	MacDonnell	Gunsberg	Gossip	Ranken	Lambert	Piper	Lee	Won	Drawn	Lost	Total	Position
1	Bardeleben	—	1	1	½	1	½	½	1	1	5	3	0	6½	1
2	Fisher	0	—	1	0	1	0	1	0	1	4	0	4	4	4
3	MacDonnel	0	0	—	1	0	0	1	1	1	4	0	4	4	4
4	Gunsberg	½	1	0	—	1	½	1	1	0*	4	2	1	5	2
5	Gossip	0	0	1	0	—	1	0	½	1	3	1	4	3½	5
6	Ranken	½	1	1	½	0	—	½	1	0	3	3	2	4½	3
7	Lambert	½	0	0	0	1	½	—	0	0	1	2	5	2	8
8	Piper	0	1	0	0	½	0	1	—	0	2	1	6	2½	7
9	Lee	0	0	0	0*	0	1	1	1	—	3	0	4	3	6

1 = won; ½ = drawn; 0 = lost game; * = forfeit.

All players are agreed as to the well-deserved success of Herr von Bardeleben. He is about 22 years of age, and resides in Leipzic, Germany. In spite of his youth, he has already taken part in two or three Tournaments, and won considerable prizes. He has a sound theoretical judgment, and, above all things, he is a very steady and cautious player, invariably playing the Sicilian Defence as second player, and never venturing upon a bold course with the first move in hand. He played in the evenings only, and thoroughly devoted himself, from beginning to end, to the task before him in a manner which will serve as a lesson to some of his less steady fellow-competitors. The following anecdote may not be out of place. When asked by the writer to visit a concert at the Albert Hall on a Wednesday afternoon, Herr von Bardeleben, after some hesitation, declined. He excused his refusal of the invitation by the following characteristic reply:—"If you play in a Tournament, you must eat well! drink well! and do nothing else besides playing in the Tournament."

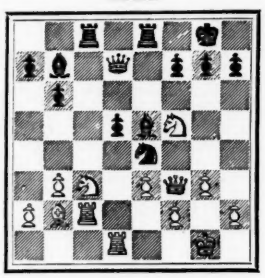
We give below a fine specimen of this young chess-artist's skill:—

Between the first Prize Winner, HERR VON BARDELEBEN and MR. J. G. MINCHIN.

White. Bardeleben.	Black. Minchin.
1. P to Q4	P to Q4
2. P to QB4	P to K3
3. Kt to QB3	Kt to KB3 (*a*)
4. Kt to B3	P to QKt3
5. P to K3	B to Q3 (*b*)
6. B to K2	Castles
7. Castles	P to B4
8. P takes QP	KP takes P
9. P to QKt3	B to Kt2
10. B to Kt2	P takes P (*c*)
11. Kt takes P	Kt to B3
12. B to B3 (*d*)	Kt to K2
13. Q to Q3	R to B sq.
14. KR to Q sq.	B to Kt sq.
15. R to Q2	R to K sq
16. QR to Q sq.	Kt to Kt3
17. P to Kt3	Kt to K5
18. R to B2	Kt to K4
19. Q to K2	Kt takesB(ch)
20. Q takes Kt	Q to Q2
21. Kt to B5 (*e*)	B to K4 (*f*)

White. Bardeleben.	Black. Minchin.

BLACK.



WHITE.

22. Q takes Kt (*g*)	B takes Kt
23. Q to Kt4 (*h*)	B takes B (*i*)
24. Kt to R6 (ch)	K to B sq.
25. Q takes Q	P takes Kt
26. R takes B, and, after a few more moves, Black resigned.	

NOTES.

(*a*) Mason played B to Kt5 in his game against English with good effect.

(*b*) B to K2 is safe and more defensive in its character, the point being not to interpose a piece between the Queen and the centre Pawns, which are the main objects of attack.

(*c*) Not to be commended. Kt to B3 instead would have answered better.

(*d*) Devoting his attention to the isolated Pawn.

(*e*) A move full of deep and hidden motives, besides threatening the centre. He also intends assailing the KKt, P with Q, Kt, and B.

(*f*) Apparently the Bishop defends the weak spot on Kt2, but of no avail. Black really had no satisfactory defence, as the position is such that it admits of various interesting combinations. If Black plays P to B3, or K to R sq., then Kt takes Kt ought to win, or, if Kt takes Kt, then Q to Kt4 wins. We give a diagram of this interesting position.

(*g*) Both brilliant and sound, and the combination that ensues gives evidence of play of the highest order.

(*h*) The key move of the position.

(*i*) Q to K3 was here necessary to save the Queen; but White would win, as he remains with a piece ahead.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

O. C. S.—Your opponent has a very slight advantage in both games.

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